

**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY
540 S. MORRIS AVE., MONTGOMERY, AL 36115
RA228 ANALYSES**

REPORT OF SAMPLE DELIVERY GROUP #1200016

Project: Dimock Residential GW Site, Dimock, PA - Follow-up work
Analysis method: Radium-228 in Environmental Matrices
Report ID: 1200016-RA228
Report type: Original
Date reported: 06/14/2012
Total pages in report: 17

SAMPLES

NAREL Sample #	Client Sample ID	Location	Matrix	Date Collected	Date Received
B2.05495G	FB22	PA:DIMOCK	WATER-DRINKING	05/22/2012	05/23/2012
B2.05496H	HW64	PA:DIMOCK	WATER-DRINKING	05/22/2012	05/23/2012
B2.05497J	FB23	PA:DIMOCK	WATER-DRINKING	05/23/2012	05/24/2012
B2.05498K	HW63Z	PA:DIMOCK	WATER-DRINKING	05/23/2012	05/24/2012
B2.05499L	HW62	PA:DIMOCK	WATER-DRINKING	05/22/2012	05/24/2012
B2.05500K	HW63	PA:DIMOCK	WATER-DRINKING	05/23/2012	05/24/2012

EXCEPTIONS

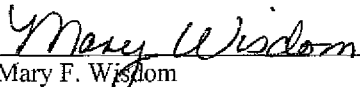
1. **Packaging and shipping** – No problems were observed.
2. **Documentation** – No problems were observed.
3. **Sample preparation** – No problems were encountered.
4. **Analysis** – No problems were encountered.
5. **Holding times** – No holding times were specified.

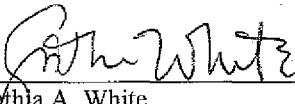
QUALITY CONTROL

1. **QC samples** – All QC analysis results met NAREL acceptance criteria.
2. **Yields** – All chemical yields were within acceptance limits.
3. **Instruments** – Response and background checks for all instruments used in these analyses met NAREL acceptance criteria.

CERTIFICATION

I certify that this data report complies with the terms and conditions of the Quality Assurance Project Plan, except as noted above. Release of the data contained in this report has been authorized by the Director of the Center for Environmental Radioanalytical Laboratory Science and the NAREL Quality Assurance Manager, or their designees, as verified by the following signatures.

6-18-12
Mary F. Wisdom
Quality Assurance Manager, NAREL
Date

6-18-12
Cynthia A. White
Acting Director, Center for Environmental Radioanalytical
Laboratory Science
Date

GENERAL INFORMATION

SAMPLE TYPES

BLD	Blind sample
FBK	Field blank
SAM	Normal sample

ANALYSIS QC TYPES

ANA	Normal analysis
DUP	Laboratory duplicate
LCS	Laboratory control sample (blank spike)
MS	Matrix spike
MSD	Matrix spike duplicate
RBK	Method blank
STD	External standard (used for ^{228}Ra yield determination)

QUALITY INDICATORS

RPD	Relative Percent Difference
%R	Percent Recovery
Z	Number of standard deviations by which a QC measurement differs from the expected value

RADIOCHEMICAL DATA

Radiochemical analyses usually require the subtraction of an instrument background measurement result from a gross sample measurement result. Both values are positive, but when the sample activity is low, random variations in the two measurements can cause the gross value to be less than the background, resulting in a measured activity less than zero. Although negative activities have no physical significance, they do have statistical importance, as for example in the evaluation of trends or the comparison of two groups of samples.

To the extent practical, it is the policy of NAREL to report results as generated, whether positive, negative, or zero, together with the "2-sigma" measurement uncertainty and a sample-specific estimate of the minimum detectable concentration (MDC). The measurement result, uncertainty, and MDC are always expressed in the same unit of measurement.

EVALUATION OF QC ANALYSES

A method blank result is considered unacceptable if it is more than 3 standard deviations below zero or more than 3 standard deviations above a predetermined upper control limit. For some analyses NAREL has set the upper control limit at zero. For others the control limit is a small positive number.

NAREL evaluates the results of duplicate and spike analyses using "Z scores." A Z score is the number of standard deviations by which the QC result differs from its ideal value. The score is considered acceptable if its absolute value is not greater than 3.

The Z score for a spiked sample is computed by dividing the difference between the measured value and the target value by the combined standard uncertainty of the difference.

The Z score for a duplicate analysis is computed by dividing the difference between the two measured values by the combined standard uncertainty of the difference. When the precision of paired MS/MSD analyses is evaluated, the native sample activity is subtracted from each measured value and the net concentrations are then converted to total activities before the Z score is computed.

Each standard uncertainty used to compute a Z score includes an additional fixed term to represent sources of measurement error other than counting error. This additional term is not used in the evaluation of method blanks.

NAREL reports the "relative percent difference," or RPD, between duplicate results and the "percent recovery," or %R, for spiked analyses, but does not use these values for evaluation.

**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY**

SDG #1200016

ANALYSIS SUMMARY

Analysis method: NAREL RA-05
Title: Radium-228 in Environmental Matrices

NAREL Sample #	Client Sample ID	QC Type	Date Completed	Preparation Batch #	Assay Batch #
B2.05495G	FB22		06/04/2012	0008797A	0016015P
B2.05496H	HW64		06/04/2012	0008797A	0016015P
B2.05497J	FB23		06/04/2012	0008797A	0016015P
B2.05498K	HW63Z		06/04/2012	0008797A	0016015P
B2.05499L	HW62		06/04/2012	0008797A	0016015P
B2.05499L	HW62	DUP	06/04/2012	0008797A	0016015P
B2.05500K	HW63		06/04/2012	0008797A	0016015P
B2.05500K	HW63	MS	06/04/2012	0008797A	0016015P
LCS-00639607X *		LCS	06/04/2012	0008797A	0016015P
RBK-00639608Y *		RBK	06/04/2012	0008797A	0016015P
STD-00639611T *		STD	06/04/2012	0008797A	0016015P

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	B2.05495G	Amount analyzed:	1.000e+00 L
Client sample ID:	FB22	Preparation batch #:	0008797A
Matrix:	WATER-DRINKING	Assay batch #:	0016015P
Collected:	2012-05-22 11:58 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QD2A	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	3.20e-01	3.5e-01	5.6e-01	PCI/L	05/31/2012 14:00 CDT

**U.S. ENVIRONMENTAL PROTECTION AGENCY
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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	B2.05496H	Amount analyzed:	1.000e+00 L
Client sample ID:	HW64	Preparation batch #:	0008797A
Matrix:	WATER-DRINKING	Assay batch #:	0016015P
Collected:	2012-05-22 11:10 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QD2C	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	1.79e-01	3.5e-01	5.8e-01	PCI/L	05/31/2012 14:00 CDT

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NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY**

SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	B2.05497J	Amount analyzed:	1.000e+00 L
Client sample ID:	FB23	Preparation batch #:	0008797A
Matrix:	WATER-DRINKING	Assay batch #:	0016015P
Collected:	2012-05-23 13:25 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QD2D	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	2.94e-01	3.5e-01	5.7e-01	PCI/L	05/31/2012 14:00 CDT

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	B2.05498K	Amount analyzed:	1.000e+00 L
Client sample ID:	HW63Z	Preparation batch #:	0008797A
Matrix:	WATER-DRINKING	Assay batch #:	0016015P
Collected:	2012-05-23 13:10 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QA1A	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	1.84e-01	4.5e-01	7.6e-01	PCI/L	05/31/2012 14:00 CDT

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	B2.05499L	Amount analyzed:	5.000e-01 L
Client sample ID:	HW62	Preparation batch #:	0008797A
Matrix:	WATER-DRINKING	Assay batch #:	0016015P
Collected:	2012-05-22 15:59 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QAIB	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	2.45e-03	8.3e-01	1.5e+00	PCI/L	05/31/2012 14:00 CDT

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	B2.05499L	Amount analyzed:	5.000e-01 L
Client sample ID:	HW62	Preparation batch #:	0008797A
Matrix:	WATER-DRINKING	Assay batch #:	0016015P
Collected:	2012-05-22 15:59 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	DUP
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QA1C	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	3.71e-02	8.7e-01	1.5e+00	PCI/L	05/31/2012 14:00 CDT

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	B2.05500K	Amount analyzed:	5.000e-01 L
Client sample ID:	HW63	Preparation batch #:	0008797A
Matrix:	WATER-DRINKING	Assay batch #:	0016015P
Collected:	2012-05-23 13:09 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	ANA
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QA1D	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	6.10e-01	8.6e-01	1.4e+00	PCI/L	05/31/2012 14:00 CDT

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	B2.05500K	Amount analyzed:	5.000e-01 L
Client sample ID:	HW63	Preparation batch #:	0008797A
Matrix:	WATER-DRINKING	Assay batch #:	0016015P
Collected:	2012-05-23 13:09 EDT	Prep procedure:	NAREL RA-03
Sample type:	SAM	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	MS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QA2A	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	3.20e+01	3.2e+00	1.4e+00	PCI/L	05/31/2012 14:00 CDT

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	LCS-00639607X	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0008797A
Matrix:	N/A	Assay batch #:	0016015P
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	LCS
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QA2B	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	1.44e+01	1.5e+00	7.0e-01	PCI	05/31/2012 14:00 CDT

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	RBK-00639608Y	Amount analyzed:	1.000e+00 SAMP
Client sample ID:	N/A	Preparation batch #:	0008797A
Matrix:	N/A	Assay batch #:	0016015P
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	RBK
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QA2C	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	7.76e-02	3.9e-01	6.7e-01	PCI	05/31/2012 14:00 CDT

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SDG #1200016

SAMPLE ANALYSIS REPORT

Lab sample #:	STD-00639611T	Amount analyzed:	1.000e+00 ML
Client sample ID:	N/A	Preparation batch #:	0008797A
Matrix:	N/A	Assay batch #:	0016015P
Collected:	N/A	Prep procedure:	NAREL RA-03
Sample type:	N/A	Analysis method:	NAREL RA-05
Dry/wet weight:	N/A	Analyst:	VH
Ash/dry weight:	N/A	QC type:	STD
Sample description:	N/A		
Comment:	N/A		

COUNTING INFORMATION

Date and time	Duration (min)	Detector ID	Operator
06/04/2012 10:53	100.0	QA2D	GVJ

ANALYTICAL RESULTS

Analyte	Activity	$\pm 2 \sigma$ Uncertainty	MDC	Unit	Reference Date
Ra228	8.25e+01	5.0e+00		%	05/31/2012 14:00 CDT

**U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL AIR AND RADIATION ENVIRONMENTAL LABORATORY**

SDG 1200016

PREPARATION BATCH SUMMARY

Preparation batch #: 0008797A
Analysis method: NAREL RA-05
Preparation procedure: NAREL RA-03

NAREL Sample #	Client Sample ID	Analysis #	QC Type	Yield	$\pm 2 \sigma$ Uncertainty	Analyst
B2.05495G	FB22	00638937J		N/A		VH
B2.05496H	HW64	00638943G		N/A		VH
B2.05497J	FB23	00638949N		N/A		VH
B2.05498K	HW63Z	00638970K		N/A		VH
B2.05499L	HW62	00638955L		N/A		VH
B2.05499L	HW62	00639612U	DUP	N/A		VH
B2.05500K	HW63	00638961J		N/A		VH
B2.05500K	HW63	00639613V	MS	N/A		VH
LCS-00639607X *		00639607X	LCS	N/A		VH
RBK-00639608Y *		00639608Y	RBK	N/A		VH
STD-00639611T *		00639611T	STD	N/A		VH

* Samples marked with an asterisk are not in this sample delivery group but were analyzed with it for QC purposes.

QC RESULTS FOR BATCH 0008797A

NAREL Sample #	Analysis #	QC Type	Analyte	%R	RPD	Z	Evaluation
B2.05499L	00639612U	DUP	RA228		175.2	0.06	PASS
LCS-00639607X	00639607X	LCS	RA228	100.0		-0.00	PASS
B2.05500K	00639613V	MS	RA228	108.9		1.02	PASS
RBK-00639608Y	00639608Y	RBK	RA228				PASS

**U.S. ENVIRONMENTAL PROTECTION AGENCY
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SDG 1200016

ASSAY BATCH SUMMARY

EXTERNAL STANDARD

Assay Batch	Analysis #	Analyte	Standard Concentration	Reference Date	Yield	$\pm 2 \sigma$ Uncertainty
0016015P	00639611T	RA228	9.07e+01 PCI/ML	04/19/2010	82.49 %	5.02 %

SAMPLES ANALYZED

NAREL Sample #	QC Type	Aliquot Size	Completion Date	Assay Batch
B2.05495G		1.00e+00 L	06/04/2012	0016015P
B2.05496H		1.00e+00 L	06/04/2012	0016015P
B2.05497J		1.00e+00 L	06/04/2012	0016015P
B2.05498K		1.00e+00 L	06/04/2012	0016015P
B2.05499L		5.00e-01 L	06/04/2012	0016015P
B2.05499L	DUP	5.00e-01 L	06/04/2012	0016015P
B2.05500K		5.00e-01 L	06/04/2012	0016015P
B2.05500K	MS	5.00e-01 L	06/04/2012	0016015P
LCS-00639607X *	LCS	1.00e+00 SAMP	06/04/2012	0016015P
RBK-00639608Y *	RBK	1.00e+00 SAMP	06/04/2012	0016015P
STD-00639611T *	STD	1.00e+00 ML	06/04/2012	0016015P

Samples marked with an asterisk (*) are not in SDG #1200016 but were analyzed with it for QC purposes